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(54) DOUBLEWALLED, LIGHT STRUCTURAL ELEMENT FOR SOUND-INSULATING PARTITIONS

(71) We, ELEKTROAKUSZTIKAI GYAR, a body corporate organised under the laws of Hungary of 5, Fogarasi-ut, Budapest XIV., Hungary do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a double-walled, light structural element for sound-insulating partitions, built together by means of foamed plastics arranged between two metal plates of different thickness. The structural element having very low surface weight performs by itself or else built together with a plurality of like elements the role of a sound-insulating partition.

Double-walled sound insulating structures are well known. The partition comprising elements parallel to each other appears as a coupled acoustical system offers more acoustic resistance than a simple walled partition structure. With the known partitions, the attachment of the two walls is secured by a rigid connection which is referred to in the literature as sound bridge owing to its sound transmission. The sound transmission rate of such double-walled partitions can be reduced—i.e. the sound resistance can be increased—by damping material disposed between the two walls, the damping material being as a rule attached to the stiffening sound bridge.

Some known double-walled partitions as well as the arrangement according to the invention are further described hereinafter with reference to the accompanying drawings, in which

Fig. 1 is a cross section through a double-walled system of conventional construction,

Fig. 2 is a front view of a preferred embodiment of the sound-insulating partition built from the structural elements of the invention,

Fig. 2/a is a cross section through line A-A of Fig. 2, and

Fig. 3 is a diagram of the sound-transmission-loss in dB achieved by the experimental elements according to the invention.

Double-walled partitions are considered theoretically as mass-spring-systems. The excitation is received by the first wall 1, while the excited mass is the second wall 2, with the spring being the air or the material 3 arranged between the two walls 1 and 2 surfaces. The attachment of the walls 1 and 2 is performed by the rigid links 4 (see Fig. 1).

Such a system operates in the range below its own resonance frequency as a whole i.e. as a one-layer partition, while the sound transmission loss of the system increases in the range above its resonance frequency with a 18 dB/octave steepness rate. The disad- the sping between the air or the material 3 that the individual wall layers retain separately its limit frequency of the so called coincidence transmission which is disadvantageous.

Now the attention of designers seems to be directed from large, 1000-3000 kp/m^2 surface weight structures increasingly towards light, maximum 100 kp/m^2 surface weight structures. A number of forms of different double partition walls are being dealt with ever more frequently in scientific publications. Such are, for instance, ribbed gypsum cardboard, hollow gypsum perlite, roughened solid wood shavings, asbestos slate and hard, closed porous sandwich-like structures consisting of polystyrene foam, polyester-foamed plastics, wood shavings, various aluminium, steelstructured and lumber-framed structures stuffed with mineral glass-wool or some other porous sound absorbing material. However, the sound transmission loss thereof fails as a rule to meet international standards.

This fact points, in addition to the uncer-

tainty prevailing throughout the theoretical and also constructional range of this subject matter also to the ever increasing part played by double walled partitions in the course of the efforts by designers to improve sound insulation and also in the domain of the developments of the building industry.

The sound transmission loss of double walled partition structures is determined at low frequencies by the structure mass per surface unit. A fairly good approximation is afforded by a known theoretical method at low frequencies. However, it fails to give a correct characterization of the sound transmission loss in the entire frequency range. At higher frequencies, however, the simplified theory fails up to a certain so-called critical frequency as far as double walled partition structures are concerned as system with concentrated mass-spring system. At the so-called critical frequency the acoustical coupling between the wall partition and the air is influenced by the coincidence of the waves propagating both in the air and in the partition material, whereby sound transmission loss decreases. It seems reasonable to shift that so-called coincidence transmission in the upper audio frequency range by reducing the thickness of the partitions by the reduction of the bending rigidity of the partitions. Owing to the reduced mass on the other hand the structure will offer a deteriorated sound transmission loss at low frequencies. In order to keep the sound transmission loss in this frequency band to the appropriate value too, it is usual to form the partition structure in such a manner that the mass of the structure should be sufficiently large and at the same time the structure should be capable of performing bending vibrations, in order to prevent the coincidence transmission. The conventional partitions can satisfy these contradictory requirements only approximately and as a rule exclusively with large structures, such as have surface weight of at least 100 kp/m^2.

Absorbent material arranged between the partitions improves the coincidence transmission referred to. The absorbent material applied is generally open or closed porous material, in most cases mineral cotton or glass cotton. Now since these latter two materials fail to have the required strength, it was not possible to build self-supporting structures with this. The cushion made of the absorbent material is as a rule attached for instance to a spanned wirescreen, and is subsequently mounted on propping and stiffening elements as comprise the partitions, these elements form acoustic bridges. The absorbent material serves at the same time as a means for attenuating the acoustic waves travelling and are reverberated repeatedly between the double walled partitions. The acoustic bridges referred to quite evidently reduce the transmission loss of the structure.

So far no theory is known, which could help to design partitions with predetermined transmission loss. Experimental results as well based upon various theoretical considerations very often show quite considerable disagreement. Besides the theoretical considerations the experimental testing of wall partitions seems inevitable.

The present invention has for its purpose to solve the difficulties referred to above, in a manner different from those known, and presenting at the same time better results.

The invention provides a double-walled, light structural element for sound insulating partitions, comprising two metal plates, arranged parallel to each other, with absorbent material arranged between the plates, wherein the two metal plates are of different thicknesses not exceeding 3 mm each and are fitted with one to four bracing members per meter of length of the element arranged parallel to one edge of one of the metal plates, the total mass of the bracing members, being three tenths to one half of that of the metal plates, the space between the metal plates being filled with a layer viscoelasticplastics foam material having open pores of a minimum thickness of 10 mm and a minimum specific flow resistance of 0.5×10^4 Nsec m^{-3} shaped to fit the circumference of the metal plates, the metal plates being attached with their faces to the two largest faces of the layer of foam material.

The present invention has for its object light, double-walled sound insulating partition structures, permitting elimination of the acoustic bridges and at the same time of high supporting power. A structural element according to the invention comprising metal plates 1 and 2 of appropriate mass—preferably iron plates—with a layer viscoelasticplastics foam material with open pores 3, arranged, preferably by glueing, between these plates 1 or 2, the layer 3 performing the task of spacing and acoustic attenuation of waves travelling between walls (see Figs. 2 and 2a). The structure thus eliminates any possible acoustic bridge. The layer 3 glued between the metal plates 1 and 2 forms a strong, self supporting structure of high supporting power. The thicknesses of the plates 1 and 2 are different from each other, and should not exceed 3 mm each, to prevent coincidence transmission. The sound transmission of the double walled structure in the neighbourhood of the critical frequencies has been reduced by the application of plates of different thicknesses. The reduction is brought about by the fact that in spite of the difference of the thickness the eigenfrequencies for bending vibrations of the plates are different.

In the structure developed in the course of experiments having the minimum surface weight, plate 1 had a thickness of 1 mm and plate 2 of 2 mm. However because the sound transmission loss at low frequencies would be too low, due to the reduced mass of the plates, the sound transmission loss of the structure was therefore improved by fixing one or more longitudinal bracing elements 5 to the metal plates 1 and 2 in a manner to keep basic modes of the bending vibration of the plates 1 and 2 below 100 Hz. It has been found that to yield the best result the total mass of the longitudinal bracing elements 5 should be 0.3 to 0.5-times of the total mass of the plates 1 and 2, while the number of the longitudinal bracing elements 5 should be at least one but not more than four per metre and per plate.

The layer 3 applied having to perform in addition to spacing also the task of absorbing the standing waves between the two partitions should have a minimum specific flow resistance of 0.5×10^4 N sec m^{-3} and a minimum thickness of 10 mm for achieving the required sound transmission loss.

In order to secure the incorporation of the structural element according to the invention and to secure the simple connection of a plurality of like structural elements, the edges of plate 1 and 2 may be bent in the same sense or at certain spots in the opposite sense, coupling elements arranged in the perforations 6 upon the bent edges being provided. The bent edges of the plates are conveniently perpendicular to the plane of the plates. The bending of the plate edges along the plate edge may be identical throughout or run in the opposite sense at certain spots, depending on the construction. The attachmetn of the individual elements is achieved by linking elements.

The sound transmission loss shown in Fig. 3 has been achieved, from the structural elements built in the course of experiments, with the partition built of structural elements having a 50 kp/m^2 surface weight and surface of approximately 2×1 m^2 each. The plates applied had a thickness of 1 and 2 mm fitted with three longitudinal bracing elements per plate and per meter, the bracing elements weighing 3.8 kp each were spaced at about 250 mm arranged parallel to the longitudinal plate edge. The polyester-plastics foam disposed between the plates had a thickness of 80 mm and a specific flow resistance of 0.8×10^4 Nsec m^{-3}. The plates were attached to the polyester-based foamed plastics with an artificial rubber-based glue. The mean sound transmission loss—measured upon a 6 m^2 surface structure—was 47.5 dB computed for a 1 m^2 area of the surface 2×10^{-5} N/m^2 as reference sound pressure.

By the application of the structural elements according to the invention double-walled, light sound insulating partitions can be built with an approximately 50 kp/m^2 surface weight—which is about the half of the weight of the known structures—and of a mean sound transmission loss of about 47 dB also possessing the appropriate mechanical power rates.

WHAT WE CLAIM IS:

1. Double-walled, light structural element for sound insulating partitions, comprising two metal plates, arranged parallel to each other, with absorbent material arranged between the plates, wherein the two metal plates are of different thicknesses not exceeding 3 mm each and are fitted with one to four bracing members per meter of length of the element arranged parallel to one edge of one of the metal plates, the total mass of the bracing members being three tenths to one half of that of the metal plates, the space between the metal plates being filled with a layer biscoelasticplastics foam material having open pores of a minimum thickness of 10 mm and a minimum specific flow resistance of 0.5×10^4 Nsec m^{-3} shaped to fit the circumference of the metal plates, the metal plates being attached with their faces to the two largest faces of the layer of foam material.

2. An element according to claim 1, wherein the metal plates are connected to the said layer by glueing.

3. An element according to claim 1 or 2, wherein the edges of the metal plates are bent throughout in the same sense or at selected portions in the opposite sense and that the bent edges are provided with perforations for the admission of attaching elements joining the element to another one.

4. An element according to claim 3 wherein the edges are bent to extend in a plane perpendicular to the plate plane.

5. A double-walled, light structural element according to claim 1 constructed substantially as herein described with reference to and a shown in the accompanying drawings.

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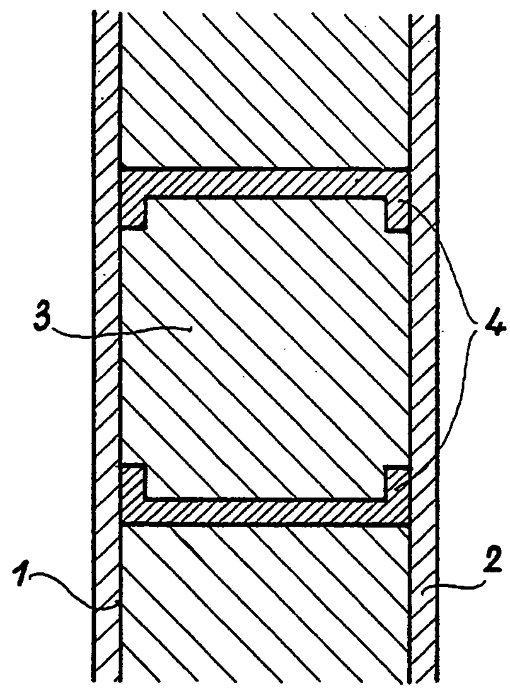

Fig. 1

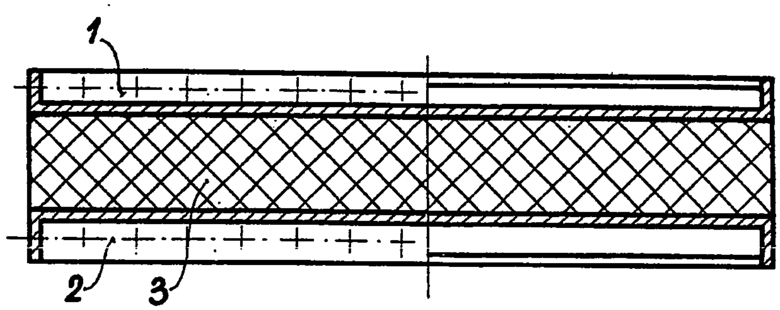

Fig. 2a

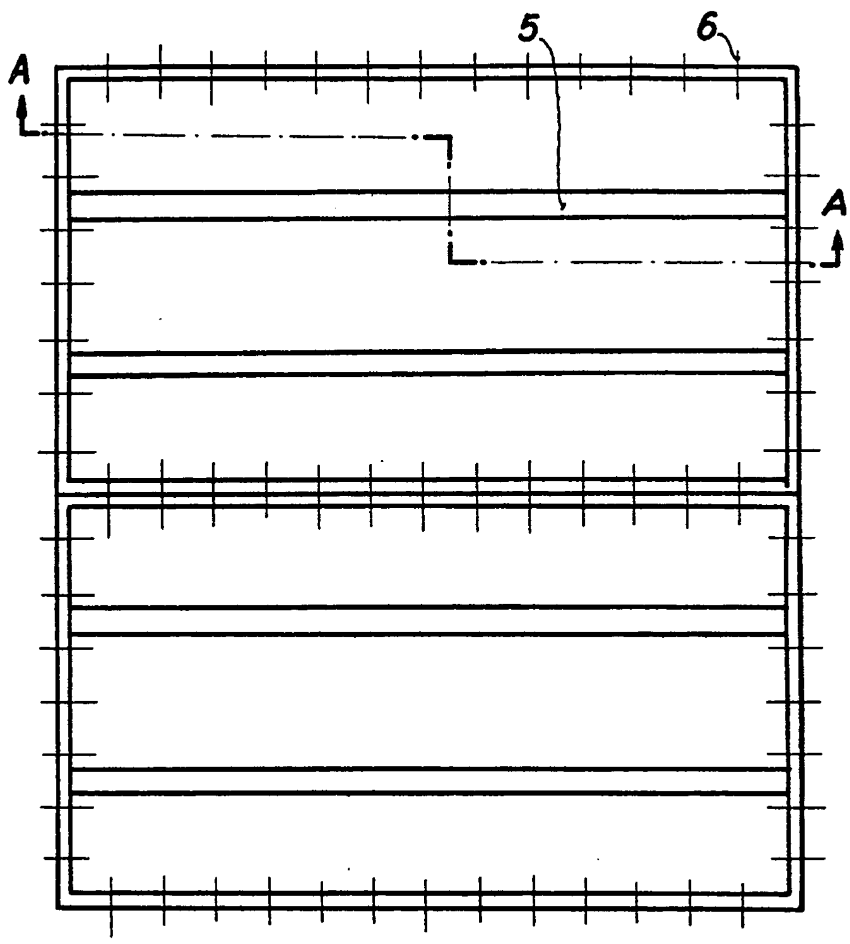

Fig. 2

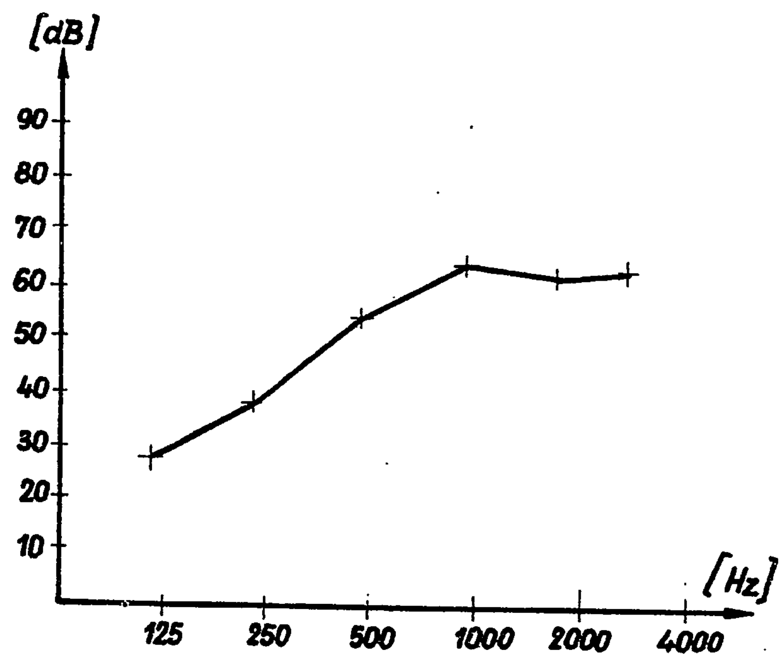

Fig. 3